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ABSTRACT

EXPERIMENTAL PROGRAMS IN THE TEACHING OF SCIENCE, INTRODUCED IN TWO SMALL SCHOOLS IN COLORADO, ARE DISCUSSED AND EVALUATED BY THE TEACHERS INVOLVED. THE FIRST PROGRAM IS A STUDENT-DIRECTED APPROACH TO THE TEACHING OF BIOLOGY, WITH AN EMPHASIS ON SCIENTIFIC PROCESSES RATHER THAN TRADITIONAL SUBJECT MATTER. THE SECOND PROGRAM OF INDIVIDUALIZED INSTRUCTION IS IN ADVANCED SCIENCE RESEARCH. A COMPLETE DISCUSSION OF PROGRAM PLANNING AND IMPLEMENTATION IS PRESENTED. IN BOTH CASES, THE INSTRUCTORS FELT THAT THEIR STUDENTS GAINED IN SELF-DISCIPLINE AND THAT THIS GAIN WOULD BE OF MUCH BENEFIT IN THEIR FUTURE SCHOOLING. ALSO, IN BOTH CASES, THE TEACHERS WERE PLANNING TO CONTINUE THE NEW APPROACHES TO THE TEACHING OF SCIENCE. (DB)

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COLORADO WESTERN STATES SMALL SCHOOLS PROJECT

DOCUMENTATION

[Individualizing Instruction in Science in the Small School]

[1964]

A Plan for Individualizing Instruction in Biology Through Student Initiated Experiments

by Deane L. Munger

Independent Study. Advanced Science Course at Meeker High School

by Marshall T. Steen

COLO. STATE DEPT. OF EDUCATION · DENVER
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THE WESTERN STATES SMALL SCHOOLS PROJECT

The Western States Small Schools Project, partly financed by a grant from the Ford Foundation, is designed to help the state education agencies in Colorado, Arizona, Nevada, New Mexico, and Utah in their efforts to improve instruction in the necessarily existent small schools. The Project began January, 1961 and will end August, 1965. Policy Board of the Project is composed of the chief state school officers of the cooperating states. Ralph G. Bohrson, Coordinator of the WSSSP, is headquartered in Denver, at the Colorado State Department of Education.

The Colorado portion of the Project, involving more than two hundred teachers and administrators in approximately thirty schools has been working in the following areas:

-- Ungraded or Continuous Progress Programs

-- Use of Self-Instructional Materials

-- Teacher Education and In-Service Programs

-- Institutes for Rural School Board Members

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A PLAN FOR INDIVIDUALIZING INSTRUCTION IN BIOLOGY THROUGH STUDENT INITIATED EXPERIMENTS

Deane L. Munger
Ridgway High School
Ridgway, Colorado

1963-64

I. OVERVIEW

This project was carried out at the Ridgway High School, Ridgway, Colorado during the 1962-63 school year. Even though the school is small (approximately 60 in grades 7-12) the classroom, material and equipment are quite adequate for carrying on this type of project.

Biology is a requirement in this school for all practical purposes--the school requires two units of science for graduation and most students use biology as one of these required courses. The average size of a science class in Ridgway is from 8 to 10 students. This was an average class, having eight sophmores as students.

Since the science classes are so small it was felt that biology could be taught through student initiated experiments and in doing so provide individual instruction. It was also planned that this approach would increase the interest of the students in science. Another reason I wanted to try this project was that in the past there had been very little laboratory work in biology and what little there was consisted of demonstrations by the teacher or student work with a laboratory manual and/or workbook. In both cases there was almost no thinking or planning left for the student to do--he just followed directions. This may have improved laboratory techniques but it did not provide for the development of critical thinking nor the use of scientific processes by the student.

With the rapid advances in all fields of scientific knowledge it would be difficult, if not impossible, to make each student proficient in subject matter. The writer therefore, feels that development in the ability to use the scientific processes would be a greater achievement and of much greater

value to the student. This is what was attempted.

Many of the new science courses that have become a part of many school curriculums are based on the laboratory approach. These include such courses as BSCS Biology and PSSC Physics. Data that has been gathered indicate that the laboratory approach is a desirable method of teaching science. In talking with teachers who have taught BSCS Biology they all agree that it is a desirable way to teach because the students gain far more than in a conventional biology course. It is also a good method for the teacher provided that he has a good line of equipment, materials and an adequate classroom so that he does not spend most of his time improvising, substituting, etc. With the above courses there are still books and manuals available for the student to follow but they are set up in such a way that the student has to work out his information for himself. In this course the writer placed texts in the students' hands but they were used primarily as a reference and there was no set plan of progress. Since the school lacked biology reference books the writer used all that were applicable from his personal library.

In starting this project the writer felt that the students needed to know more about their environment--the area in which they live--and also about themselves. In the traditional biology course much of the material was difficult for the student to grasp because he was unable to relate it to his own life and environment. The writer felt that if the student worked with something familiar or, at least that with which they had periodic contacts he might develop more of an interest in his surroundings and that this increased interest would mean that he would be better able to grasp the biological principles and concepts that would be of value to him. Also, with so much scientific material being discovered daily the ability to draw inferences and conclusions from available data and observations seems more important than knowing a lot of subject matter. In an attempt to fulfill these needs the writer decided to try teaching by use of student initiated experiments in

areas of their own interest.

In reviewing the students' permanent records it appeared that this class was an average class in mental ability but on the whole, they could be called underachievers. Grade school grades were higher than the tests (such as Iowa Basic Skills) given them indicated they should be. After reaching high school their grades dropped below those received in the grades. This probably had some influence on their attitude toward school and their work in school in that they have to be pushed constantly to do their work and seem to lack self-confidence in their work. They are never sure of what they have done or what they want to do.

Reading speed and comprehension tests were given and the highest speed was 260 words/minute with 80% comprehension and the lowest was 140 words/minute with 40% comprehension. One had a speed of 200 words/minute with 90% comprehension. This probably had some effect on their research work in biology and tended to slow them down until they would lose some of their interest.

The following table was taken from the permanent records of biology class members:

Student	School & College Ability Test			IQ
	Verbal	Quantitative (percentile band)	Total	
A	10-24	44-70	26-30	95
B	8-19	20-41	10-23	95
C	--	--	--	103
D	--	--	--	99
E	34-56	68-90	58-71	119
F	--	--	--	106
G	8-19	27-55	14-29	98
H	39-61	33-60	45-58	102

II. PROCEDURE

At the beginning of the school year the project was explained to the students. They were told that the course would be based on experiments which they devised or had found out about in their readings in the areas in which they were interested. If the class so desired we would also have class discussion in areas that our facilities did not allow experimentation in or just a general discussion to open new areas for experimentation. The writer also explained that they would be evaluated on their attitudes, industry, originality, improvement, techniques, observations, and inferences and conclusions from the data they collected. If they felt that this was too much of a change from the traditional methods of evaluation to have their grades based on it, the writer would give tests over the subject matter and base their grades on such tests.

At this time some of the basic laboratory techniques were demonstrated and this was followed with student practice in these techniques. Some of these were the use of microscopes, preparation of wet slides, measurement of chemicals, etc.

Along with this, field trips were taken to point out many areas that could be studied if they did not have any ideas of their own at this point. Trips were made to a sagebrush-pinyon-juniper hillside, a warm water ditch bank, a pond, and a stream. Materials were collected on these trips and brought back to the classroom.

Only readily obtainable materials were used by this biology class. Either they were commercially available so they could be conveniently purchased or they were materials which the students could bring from home. Of course, we also had those plants and animals which were collected on our field trips. Organisms that were hard to care for or that required special equipment were discouraged unless it was felt that the student understood the complications

and was still willing to proceed under certain handicaps.

Each experiment was discussed with the teacher before the student attempted to carry it out. In doing so the student was able to determine if the proper materials and equipment were available to carry out the experiment with a minimum of handicaps. This prevented a student from attempting an experiment in which he would be forced to stop during the course of the experiment because of the lack of materials and/or equipment.

Class activities included working on their experiments, research on experiments, consulting the teacher about proposed or proceeding experiments, group discussions of individual findings and of areas that they were unable to experiment in because of the difficulty or the lack of materials and equipment.

The writer felt that the group discussions of individual findings were a most worthwhile activity at the beginning of the year. The students exchanged ideas and questioned each other very well and seemed to gain a lot from these discussions. As the year progressed the ideas presented remained on the same level and the questions asked became small trivial questions that did not really apply to the problems being discussed. At this time the group discussions became less frequent and more time was spent on individual laboratory work. With the extra lab work some of the students appeared to become tired of it and wanted to have more discussion on topics presented in the text. The students were about evenly split on this idea--some wanting all the possible lab time and the rest wanting to work from the text. To compromise, we cut the lab time a little and started having discussions of student-chosen topics in the text.

During laboratory work the students were completely free to move about and discuss their work with each other. The teacher had to be aware of what was going on to keep a curb on idle chit-chat and senseless wandering that was only a pretense of doing work. As this becamse more common as the year progressed it seemed an indication that so much laboratory work was becoming tiring to a

majority of the class.

There could be no long range planning of class activities because the ideas of the students were in constant flux--they changed not only from week to week, but from day to day. Since the writer wanted the students to explore their environment--and since these "explorations" could turn in any direction--and did, about the only thing the writer could do was to keep a close watch on the progress of the students and see that suitable materials, equipment and references were available so that they could progress with a minimum of delay.

Whenever there appeared to be a natural break in most of the students' work we would take a short field trip and attempt to apply some of their findings to their environment and to open new ideas upon which they might work. Examinations, exercises or demonstrations were also planned for these breaks. These included reading speed and comprehension tests, demonstrations on conditions for optimum learning, etc. in which the whole class would participate. After each such activity every student was able to confer with the teacher on the results if he so desired.

It was very difficult to get the students to accept a failure with an experiment. They were ready to throw it out if something came up that they had not anticipated. It required much effort on the part of the teacher to get them to think back through their procedures, re-examine their hypothesis and re-evaluate their data to determine why it didn't turn out the way they had anticipated. The writer felt that experimental "failures" were just as good, if not a better learning situation, but had doubts if the students really gained anything from their failures. Students--and their teachers--have confused exercises and experimentation. There has been too little work with scientific methods and too much where the results were already determined and all the student did was to follow step-by-step directions.

When the students became too discouraged the writer became more cautious about allowing them to undertake certain experiments so that there was a higher

percentage of "success." If the student was determined on doing a certain experiment then the writer would attempt to point out as many pitfalls as possible so that the student would be more aware of what could happen and why.

III. EVALUATION

In evaluating the results of this project many areas were considered such as attitudes, industry, originality, improvement or progress, techniques, accuracy in observations and the ability to compile data and make valid inferences or conclusions from them. Subject matter was also tested. At the beginning of the year these areas were discussed with the students and during the year tests were given on different areas to help determine their progress and to re-emphasize scientific processes. Observation by the teacher to see if the students were putting these processes to use in their daily work was the major evaluation of their work.

The following were examples that are typical of those used on various tests:

You are designing an experiment to test the effect of different wave lengths of light upon the amount of growth in young Coleus plants. Place a circle around the number for each statement indicating a procedure which would be desirable in adhering to sound principles of biological experimentation.

(1) Select a number of plants of uniform size, shape, leaf area and color.

(2) Subject all plants to the same light intensity.

(3) Vary the temperatures around the different groups of plants to determine what effect that will produce.

(4) Control plants under white light may be selected later from among those left in the greenhouse.

(5) Subject the plants to at least 48 hours of darkness before beginning experiment.

(6) Plants grown from cuttings will be more suitable than plants grown from seeds.

(7) To measure growth, leaves may be selected at intervals from the plants and their content of starch determined.

(8) Be certain that the soil is of uniform consistency and mineral content.

(9) Control plants may be grown in the field next summer to obtain natural conditions.

(10) Select at least three plants and provide a different amount of light around each of the three plants.

(11) Divide the plants into at least four groups and subject three different groups to light of three different wave lengths and one group to white light.

(12) Provide equal amounts of carbon dioxide around each group of plants.

(13) Water all plants uniformly.

(14) Keep the temperature uniform around all plants.

(15) It will be better to measure amount of growth by noting increase in length of stems rather than by determinations of oven-dry weight.

The distribution and size of stomata on the leaves of certain plants.

Plant	Average no. stomata/sq. mm. lower epidermis	Average no. stomata/sq. mm. upper epidermis	Aver. size in μ in lower epidermis when fully open
Alfalfa	138	169	--
Apple	250	0	--
Basswood	130	0	--
Bean	281	40	3x7
Cabbage	226	141	--
Castor bean	176	64	4x10
Coleus	141	0	5x10
Corn	88	69	--
Elodea	0	0	--
Geranium	59	19	12x19
Lilac	530	1	--
Nasturtium	130	0	6x12
Oats	23	25	8x38
Pea	216	101	--
Potato	161	51	--
Sunflower	156	85	8x22
Tomato	130	12	6x13
Tradescantia	14	0	12x31
Wheat	14	33	7x38

Study the data in the above table. List all justifiable inferences.

Tests using problems such as the two above give the teacher a definite means of evaluating the students' work and progress. Many times when the evaluation

is based on teacher observation of the student's activities bias creeps in regardless of how the teacher attempts to avoid it.

Traditional objective and subjective (short essay) tests were given to the students also, with the most emphasis on subjective tests. The final, or term, grades were based on a combination of the above mentioned areas.

In general the rank of the students' scores on "thought" tests (examples given above) did not coincide with SCAT, Iowa Basic Skills and IQ tests. Students scoring highest in the above tests were average or below average on tests recorded in their permanent records (SCAT, etc.). Students scoring high on permanent record tests were average or below on the "thought" type tests. It is difficult to get a good correlation as the class was very small and some of the students do not have complete or similar data on their permanent records.

In comparing this class with the previous biology class (1961-1962 school year) the writer found the average of this class to be 11 percentile points lower on one standard achievement test and 17 points lower on another. Of course, in the preceding class, subject matter was the backbone of the course whereas scientific processes were the main part of this year's course.

According to the objective type tests this type of teaching does not give the students the subject matter or factual information that the conventional course does but the writer feels that they have gained a much greater knowledge of scientific thinking and processes. The writer believes this procedural knowledge will be of greater benefit to them in our constantly changing world--where scientific knowledge is ever changing and increasing in scope and depth.

Many of the students demonstrated a definite growth throughout the year, while others showed no observable change. In general, about half of the class enjoyed the laboratory approach to biology while the other half had their ups and downs--sometimes working very hard (particularly when everything

was going according to plan) and at other times showing no desire to do anything.

This was the first year (in five years of biology teaching) that the writer felt the parents were definitely aware of what was going on in the classroom. Many of the students were carrying their problems home and asking parents for ideas, comments and help. In some cases the parents became very interested and were also asking questions related to the student's work--not about how their child was doing in biology but rather about the results of class experiments, etc. Some parents were primarily concerned if their child was learning sufficient biology to do them some good in college. Of course, we had some parents who showed no concern at all as to what, if anything, their child was doing. It seemed that the increased parent interest and concern helped make this a most worthwhile project.

This type of teaching proved very interesting and challenging. There is more teacher work involved--but the results were more than normally rewarding with some of the students. In a few cases it was felt that the students really accepted the challenge and developed greatly through the year--both in techniques and interest.

RECOMMENDATIONS

In the coming year this approach, in modified form, will be used to a certain extent in my other science classes. It has opened new horizons in the teaching of biology and encouraged the writer to try it again in the coming school year--where it is hoped it will be even more effective because of this year's experience.

If other teachers were to follow this method of teaching the following would be guidelines which I would recommend:

(1) The teacher must be convinced that the students will benefit from this approach and that they will provide the basis for developing the course.

(2) He must believe that the processes of science are more important and valuable to the student than the products of science.

(3) The formality of the class must be dropped in the strict sense and the students must be allowed to act freely on their own--but always with the awareness that the teacher is still in control.

(4) He must be convinced that all the students can make contributions to the class.

(5) The teacher must constantly be aware of the overall growth and development of all the students individually and collectively.

Independent Study

ADVANCED SCIENCE COURSE AT MEEKER HIGH SCHOOL

TEACHER: Marshall T. Steen

SCHOOL: Meeker High School

LOCATION: Meeker, Colorado

DATE: June, 1963

CLASS SIZE: Four students

SCHOOL PROJECT DURATION: The initial class was organized in the 1960-61 school year with four students, was continued in 1961-62 with four students and in 1962-63 with four students. From the preregistration results, it appears that there will not be a need for such a class in 1963-64. The course is set up whereby it can be put into the curriculum at any time without need for working it into the school schedule or a need for obtaining additional instructors.

Need indicated by student data, curriculum deficiencies and student behavior

Top ranking students that had taken the biology, chemistry, physics sequence indicated a desire to continue studies in the sciences.

Follow-up studies on our graduates from former years, which included personal contacts, gave evidence that any additional help that could be given in this area would be a helpful one.

Meeker High School requires twenty-two credits for graduation. The schedule of classes is set up with six hours in the day plus a half hour activity period. There are no study halls as such with each teacher requested to allow about twenty minutes at least during the period for study purposes. As a result, with six classes a day, it is possible to get a maximum of twenty-four credits during the four years of high school. With this large number of courses open for them to take, students find it possible to take as many as six courses in science if they wish. This

would include general science as a freshman, biology as a sophomore, biology II and chemistry as a junior, and physics and advanced science as a senior.

What unique advantages or weaknesses of the small school situation prompted this effort

It is without question that large high schools are able to offer a greater variety of subjects than a small high school can. Also, because of the large number of students, it is possible to get larger numbers of students in these classes and this warrants hiring additional teachers for this purpose.

In the small school situation, existing teachers must be used. The unique advantage of this advanced science class as it is set up is that it requires a minimum of teacher time, does not require a change in class scheduling, can be worked in any period or periods in the day and it can be taught to any number of students. In fact, the smaller the group, the better this works out.

An attempt was made to find actual research made relating to this project, but was unable to find any.

An article written by Dr. Joseph J. Schwab of the University of Chicago and Chairman of the Teacher Preparation Committee based on "Inquiry, the Science Teacher, and the Educator" printed in the School Review, summer issue, 1960, points up the thinking I have had. The following quotes from this article I feel will clarify the issue. As you will note, this idea is not necessarily relegated only to a small school situation, but it can work out in any size school.

"To avoid these unintended meta-consequences of our teaching, we need to imbue our courses and our exposition with the color of science as inquiry to give the student an effective glimpse of the vicissitudes of research.

"The teacher whose past training involved passivity and dependence and who tends to demand the same of his students, will need, in addition, to discover the possibilities of self-education--not only for himself but for his students. There are two reasons for this suggestion.

"First, self-instruction is the only practicable solution to the problem of "coverage." The problem of finding enough time to "cover" what we wish to cover is not and, for years, has not been, a problem of finding enough student time. It has been a problem of finding enough classroom time and enough teacher time to "cover," in the conventional way, within the conventional framework of the school day, on the assumption that all "coverage" must be coverage in the classroom. I now suggest that a substantial part of "coverage" be "covered" by the student on his own.

"Second, self-instruction skill is of great post-school value. For the teacher, it will free him from dependence on inculcative summer refresher courses and institutes and free that time for more interesting and constructive work. For the layman, it will give access to books and magazines from which he is able and willing to learn without the crutch of formal classes and instruction.

"Self-instruction must become pervasive if it is to be effectively developed. If science classes alone demand it while others do not, the students will view it as a special and unreasonable imposition. If all departments demand it, it becomes a regular part of the school experience and students will soon cease to be intimidated by it.

"I believe that in the present climate of attitude and habit, inquiry will be immediately accessible only to a few. For most students entering high school in the next year or two, it will be a shocking change of pace. For most high school students entering college in the next few years, it will come as a similar shock. But this very sequence suggests what the future can hold."

Today, the American student must assume more and more individual responsibility for his academic achievement if his later progress is to be enhanced. No longer can the student who has failed to realize his capabilities place the blame entirely upon the teacher. To develop responsibility the student must be given a chance to assume responsibility. Dr. Crnkovic of the Brigham Young University Laboratory School states, "We speak of teaching the individual child but we end up teaching the class as a whole." In a class such as this advanced science class designed primarily for individual research, this is well nigh impossible.

The philosophy of this class is much like that of the programed learning type class where each student is allowed to progress at his own rate to enable him to derive maximum benefits from the educational program.

The problem and need

Since the high school has done away with study halls and has required students to take six subjects per day, it has made it possible to work in additional courses for the able and ambitious student. The latter has posed a problem in the fact that we have hours available for these students to take these courses but no additional teachers.

Students proposing to take science oriented courses in college need all the background that it is possible to give them to better prepare them for the rigorous requirements to be met in college.

To quote the New York Mirror, "Our national survival hinges in great part on an adequate supply of scientists and specialized manpower to ensure our technological progress." These must come from both the large and small high school.

To give an indication as to the use this course may have to the individual student involved in this year's class; student "A" has accepted an appointment to West Point Military Academy, student "B" is setting up

his college course to lead to a medical doctor's degree, student "C" is planning to take a course in electrical engineering and student "D" plans to become a dentist. All of the students had the option to accept one or more scholarships to a number of colleges and universities. Student "A" and "B" attended the Climax Molybdenum summer institute in science at Colorado State College of Education at the end of their sophomore year, students "B" and "D" attended the Science and Humanities Symposium at Utah State this spring as the result of research papers sent in for evaluation, student "D" presented his paper on the "Making of Artificial Hailstones" at this symposium where he was awarded a Litton Industries trophy for excellence, student "D" also attended the National Symposium on Science and Humanities at West Point this spring and student "D" attended a National Science Foundation summer institute on atmospheric physics at the University of Nevada in the summer following his junior year. From this list of accomplishments and aims, you can readily see that the caliber of students was high and the opportunity to do individual study was made use of.

Organization of the study and procedure

After senior students have taken chemistry, physics and biology, and have maintained at least a 'B' average in these courses, they may take the course in advanced science. This course is designed as an individual research course.

At the beginning of the year, I meet with the students to decide on the subject areas in science where they would like to spend additional time. Blocks of time are then laid out outlining the year's work. This is a flexible thing where the time spent may be shortened or lengthened as the year progresses. I act in a supervisory and advisory capacity with a few lectures spaced through the year.

The students choose the hour in the day which best fits in to their class schedule. For example, this year three of the students met second period when I have a General Science class and the other student has sixth hour when I have chemistry and physics classes. The students are given the freedom of moving between the library and the laboratory as they choose depending upon which phase of the work is being pursued.

Some of the subject areas we have covered have been topology, anatomy and kinesiology of a cow's head, the sun as scientists know it now, the effects of electrical impulses of small voltages on animal behavior, insect collection and taxonomy, meterology, animal populations, plant ecology of the ridge north of the school, plant toxonomy, electricity and electronics, rocks and minerals, the nature of the universe and plant morphology.

When the students were working on individual research, either or both primary and secondary as they chose, an arrangement was made with their English instructor to have this coincide with his instruction on research paper form and procedure. In this way, these students were given an initiation into the writing and setting up of a research paper in proper form. This will be excellent preparation for the many required papers they will have to do in college. This, I feel, has been a sadly neglected area in high school instruction. Please see the results of this research appended to this paper.

We worked out a library exchange with other libraries such as the University of Colorado and the Air Force Academy library to supplement research materials from our library for their papers.

This year, I also have two students taking their physics course through the use of the Dr. White films. Student "C" plans to go into electrical engineering and sat in on the films pertaining to electricity, magnetism

and electronics to help him improve his background in this area.

Evaluation

I have the results of the Iowa Test of Educational Development taken in their junior year which has as part of it's score evaluation, Background in the Natural Sciences and Interpretation of the Natural Sciences. This test was again administered at the end of this year.

On page. 75 is given the results of these tests together with the final grade average for each student (A-4, B-3, etc.), the results of the scholastic aptitude test and their I.Q. based on results of the Lorge Thorndike Intelligence Test.

As you will note, from March of their junior year to May of their senior year standard scores either remained the same (one case with student "B" on test 2) or they were increased. Student "C", who is an average student with average abilities, showed the greatest improvement. The other three students are all above average students and had less room for statistical improvement percentage-wise.

I conclude from this one set of tests, although this may be a precarious thing to do, that this course has proved to be of benefit. The research papers give evidence of a great deal of effort expended and knowledge gained.

After consulting with former graduates, who have taken this course, I find there is a definite indication that the introduction of this course has proved to be of value. To give one small example, one of my former students came to me a few days ago and said she had run across some books at college that she thought I might use to good advantage in this course and would bring them home on her next trip to Meeker for our use.

This course has been offered for three years with an enrollment of

four each year. This is the first year it has been under the WSSSP as a project area. Because the plan for execution of such a course involves a small amount of teacher time and it is possible to schedule students during any free period students have in the day, it helps to allay the problem mentioned above; that of time available to teach them.

Conclusions and recommendations

In addition to being seniors and having at least a B average, care must be taken to screen those students entering the advanced science course because of the liberties allowed. This class demands acceptance of considerable responsibility for educational progress on the part of the individual student. I suspect, to be truly effective for more students, some aspects of the plan must be introduced in the early school years with gradual expansion and increase in individual responsibility as the student matures.

The advantage in using a method such as that used in advanced science is that it makes it possible to give advanced training to small high school students without the expenditure of much more teacher time or additional money. I feel that individualization of instruction, the more effective utilization of personnel and a more effective organization of the school are three things we should constantly strive to improve.

To me, the three years of this program has convinced me that the course has high merit and is filling a needed void.

IOWA TESTS OF EDUCATIONAL DEVELOPMENT

Student	Test 2, Background in Natural Science (standard score and percentile)		Test 6, Interpretation of Natural Science (standard score and percentile)		Final Grade Point	Scholastic Aptitude Test	Lorge Thorndike I.Q.
	3/62	5/63	3/62	5/63			
"A"	29-99	30-99+	28-98	33-99+	4.000	M-707 V-606	136
"B"	25-94	25-91	30-99	31-99+	4.000	M-696 V-613	135
"C"	23-87	27-96	18-70	27-95	3.063	M-469 V-370	110
"D"	26-96	27-96	27-97	31-99+	3.854	M-608 V-593	137